5. Modulation of autoISF aggressiveness. V 2.4

Please note that with autoISF 3.0 you are in an early-dev. environment, where the user interface is **not optimized for safety** of users who stray away from intended ways to use. Good safety features exist, but these are only as good as the development-oriented user understands and implements them. This is not a medical product, refer to disclaimer in section 0

Once the initial tuning according to section 4. is done, you are ready to use autoISF for your fully automated meal management.

You will have three major *other* challenges to manage:

- recognize and manage (partial) occlusions, or other technical (CGM or BT related) obstacles (see section 2 on pre-requisites of FCL, and related case studies)
- deal with times when insulin given by the loop must be restricted (e.g. a snack could be “misinterpreted” as a meal)
- deal with times when the loop should be set "milder" as a precaution (e.g. nights; or in an exercise context).

How big the remaining challenge is depends very much on your individual lifestyle. Sections 5 and 6 discuss this in more detail.

In order to run the loop fully automatically around the clock, the times outside the meal blocks must also be precisely analyzed, and solutions to problems (if any) must be sought.

It is up to every user to decide where to draw the line.

- With a technically well functioning system, moderate meals, moderate or no exercise, moderate %TIR expectations and a bit of mindfulness it should be possible to go into Full Closed Loop 24/7, after working through, and observing, sections 1-4.
- Especially if you are a bit shy of using the emulator for really detailed analysis, it is likely that you will not hit *one* real good system calibration (section 4) for your *entire range* of diets.

  In that case you will occasionally run out of range, and your options to prevent, react, or improve are

- accepting a few % higher time outside range for that day (and, if feasible, in the future avoiding what seemed to have caused it)
- taking a snack (whenever you tend to go low from the “tails” of insulin activity that was required to fight a peak)
- doing a manual override (if you can think of one in time, to manage the problem manually)
- temporarily resorting to the well-known hybrid closed loop.

Instead of accepting such instances, you could launch “improvement projects”

- that refine your initial tuning (section 4.)
- that make you and your FCL loop fit to manage an increasing number of disturbances either automatically, or via a user intervention (sections 5-6).

To tailor the loop’s response to disturbances *other-than* your major meals probably will require specific **modulation of the aggressiveness** that you set according to section 4 for your meal management.

There are many avenues to achieve this. The main ones, that are also easy accessible via Automations in AAPS, are:

- temporary shut-off SMBs (odd-numbered target)
- temporary reduce bgAccel_ISF-weigh
- temporary reduce iobTH
- temporary reduce set %profile
- temporary set higher TT (especially in connection with exercise mode)t

In setting up your FCL, you now have another difficult and time-consuming job at hand, to define solutions for any of your „other“ situations (outside of meal management) that tend to drive glucose outside of the desirable range.

- In section 5.1 we explore avenues towards fully automated management that in daily life will require no user intervention at all.
- In section 5.2 and 5.3 we will look at solutions that involve an easy user interaction like a data entry or button push.

5.1 Fully automatic modulation of FCL aggressiveness

The following subchapters describe set-ups you may want to use for allowing completely hands-off FCL in as many daily situations as possible.

5.1.1 autoISF adaptation switched off outside of meal-time windows

If, aside from having to bolus for meals, your *hybrid* closed loop was running pretty well *without* other interventions from your side, you could continue to run in that mode, and just focus your FCL (= adaptation to glucose behaviour by your new autoISF) on management of meals.

> In your initial transitioning phase this approach makes a lot of sense, even by focusing autoISF adaptation to glucose behavior on *just a sub-set* of them, like only dinners.
>
> Note that SMB range extentions (and also the SMB delivery ratio) coming with your autoISF settings *remain in place 24/7*. Depending how well tuned your former hybrid closed loop was (with respect to *not* bouncing against the *then* lower SMB size limits) you might need further precautions, like setting a temp. lowered %profile (or an adjusted temp. iob_TH_percent) for your time windows outside of FCL meal management.

This *intermittent hybrid closed looping* avenue is taken by many FCL users for the night times, “hanging on” to their well performing hybrid closed loop with standard oref(1) SMB+UAM

> (A very good alternative is FCL with night time SMB shut-off, see next section 5.1.2).

For this, you define Automations

- that set meal time windows in which “autoISF / Enable ISF adaptation by glucose behaviour” is turned *ON* in AAPS preferences/OpenAPS SMB
- *or:* that turn *all* autoISF’s ISF modulations (*or* just *bgAccel_ISF*) *OFF* in time windows in which surely no meal occurs. For instance, you can go for all nights back into your Hybrid Closed Loop, as you had before.

> Other early DEV AAPS variants (see section 13.3) all work with meal-time windows. The window is either set by time of day in the settings, or it always must be „set“ by the user via giving a mandatory small pre-bolus before any meal starts. **Outside** of these time windows, these loops then runs with less aggressive SMBs like oref(1) SMB+UAM in AAPS Master.

This mode is not really FCL, but an advance over traditional HCL that often achieves satisfying degrees of automation and performance.

The term **Meal Announcement** (MA) is often used to label this closed looping mode. Trigger to set a meal time window could also be a pre-bolus given by the user, a carb entry made, an EatingSoonTT set, or a meal announcement button pushed.

Note: Outside of the meal time windows you would be in hybrid closed loop. To the extent you rarely face disturbances (aside from meals), you could be looping in full automatic mode around the clock,

Your temp. shut-down of ISF adaptation by glucose behavior (core autoISF function) is meant to prevent problems from the loop over-reacting to bumps in the glucose curve in times of day (night) when standard oref(1) performance is sufficient.

5.1.2 Odd-numbered *profile* targets used to block SMBs

An alternative route of preventing the FCL loop from over-reacting to bumps in the glucose curve would be to make use of the option to temporarily shut down SMBs

Ensure the even/odd logic in the settings is toggled on in Preferences> openAPS SMB> autoISF settings> smb delivery settings>: "Enable alternative activation of SMB depending on profile target" ON.

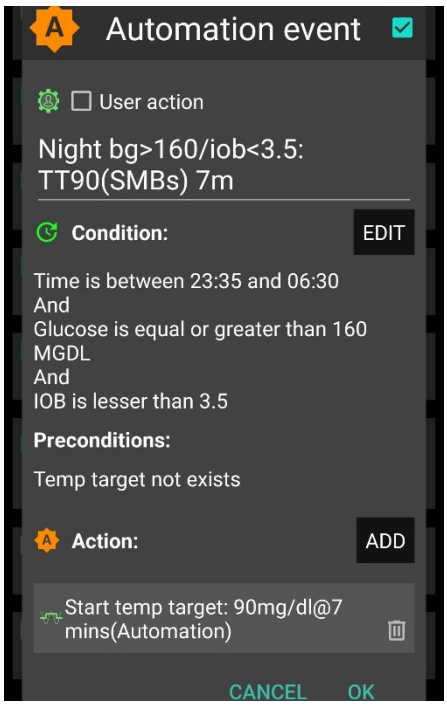
In time blocks with an odd-numbered profile target you can prevent any SMBs being given by your loop. The (unchanged) aggressive settings (that still will do strong adaptation of ISF to glucose behavior) then can only translate within the limits set by %TBR possible.

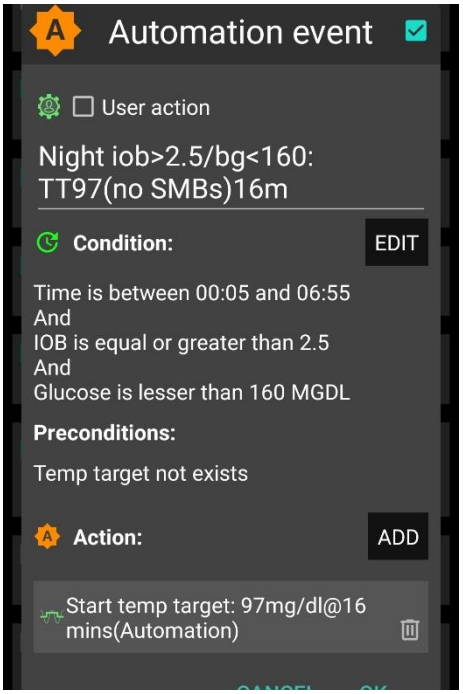
This will very much slow down any more insulin being given, and is an excellent solution for night times, especially if you occasionally experience compression lows.

Alternatively, you could use the new included options for Automation Conditions and temporarily tune your bgAccel_ISF_weight much lower (section 5..).

Yet another alternative would be to go into hybrid closed loop for the night, with or without SMBs (section 5.1.1).

In case you occasionally do have nights that would benefit from a couple of SMBs (to treat temp. highs from a late fatty pizza, raclette and such): Define suitable Automations like the two „night“ ones in this *example:*





Never underestimate the „trickyness“ of getting your Automations „right“.

With your thought-out Automations in place, night data need to be analyzed to see

- whether the bg and iob limits defined in the given example work sensibly four *your* data pattern
- whether the TT duration is chosen appropriately
- how swapping the sequence in which the automations appear in the Automation list would lead to different SMB impacts.

5.1.3 Odd-numbered *temp*. targets (TT) used to block SMBs

A widely used ACTION that strongly modifies how fast your FCL can add more iob is setting an **odd**-numbered **temp. glucose target** which makes the loop operate without giving any SMBs (%TBR modulation only).

Ensure the even/odd logic in the settings is toggled on in Preferences> openAPS SMB> autoISF settings> smb delivery settings>: "Enable alternative activation of SMB depending on TempTarget" ON.

So, from patterns you find in YOUR data, at times where you want your loop act differently, you need to carve out *CONDITIONS* that describe the respective situations (and either for how long it typically lasts, or at which *other CONDITIONS* you want your loop get back to default FCL operation).

An odd TT is often set for an *anti-hypo* snack *or sports* snack. In both instances, you do not want SMBs to quickly counter act.

In case of *sweet "fun"* snacks, this is entirely different -> section, 5.2.1 or for regular snacks (*e.g.at school break*) see next section 5.1.4

5.1.4 Automatic differentiation of FCL aggressiveness using Automations

Personalized Automations tailor the loop exactly to **YOUR** data so **fully automated handling** of situations with different aggressiveness of the loop can be made.

From, autoISF 3.0 onwards, also the following parameters are provided as *CONDITION* and/or as *ACTION* for defining YOUR Automations:

- Enable ISF adaptations by glucose behaviour => Allows temp. ON/OFF for the key ISF modulation parts of autoISF (and, as a result, will usually decrease loop aggressiveness)
- Trigger/set iobTH percent => Keeps default aggressiveness, but only until a iob threshold (that your Automation modifies) is surpassed (which is when any further SMBs will be blocked blocked)
- Trigger/set bgAccel_ISF_weight => Modifies the default aggressiveness of just the acceleration component

To set up suitable Automations, you first must **analyze patterns** you find **in YOUR data**, at times (or geo-locations, or bg and iob patterns that point to a problem …) **where you want your loop act differently**, to carve out *CONDITIONS* that describe the respective situations (and either for how long it typically lasts, or at which *other CONDITIONS* you want your loop get back to default FCL operation).

A variant of this mode is to define several meal time windows in which autoISF aggressiveness (bgAccel_ISF_weight) and/or iobTH are set differently

- for different meal time slots of your day –

  (*Breakfast at home, school lunches, school intermission snacks, dinners at home* could for example all deserve special settings regarding ISF_weights and iobTH).

- or even for a geo-location etc –

  (*School lunches, or mother-in-law visits, would be examples*).

Unless your meals differ vastly in size and in fast carb content all this may not be needed.

Still, personalized Automations might help ease your initial job of setting the various ISF_weights, and a best-suitable iob_theshold_percent that would work “always”.

5.1.5 Automatic adjustment of FCL aggressiveness via the Activity Monitor

With the autoISF variant of AAPS you can make use of your smartphone‘s **stepcounter** and use it to fully automatically adjust insulin sensitivity ratio to activity level in the past minutes to one hour time frame.

This is another little tuning opportunity, in which you study your body’s response to light exercise (like walking) or to not moving at all (like desk, couch), and select appropriate settings which, in the future, will automatically adjust insulin delivery to suit activity state of the past minutes (up to 1 hour).(AAPS Preferences/OpenAPS SMB/Activity modifies sensitivity/ -> set **two scaling factors**.)

This autoISF feature (new since V.3.0) is much quicker responding than Autosens or dynamicISF to adjust insulin sensitivity to your current „lifestyle state“.
For loopers who do not have huge variations in exercise levels in their everyday lives, this feature might fairly much close the gap towards being able to do a 24/7 hands-off FCL.

More see sections 3.5 and 6.5

5.1.6 Pro/con completely hands-off Full Closed Loop

To stay 24/7 in a completely „hands-off“ FCL can be a realistic goal with autoISF 3.0 if besides meals also some special challenges, as discussed in this section 5.1., were analyzed and could be addressed.

Clearly it depends very much on your lifestyle, and how interested, willing, and capable you are to recognize, deal with, (and in the future avoid?) situations that get you outside of your desired %TIR on occasion.

> So, this is also about what %TIR you are aiming at, and can accept, as it averages out for the week, for instance.

Everybody must weigh for her/himself

- how much **upfront effort** to put into getting it all 100% automatic
- **or** whether to take an **easier start, with a couple of situations left to take care of when and as they arise in daily life**

Also, even if a principal capability for a fully automatic running FCL is given, this still means that

- the user should be knowledgeable about what exactly is going on, and
- has a principal capability to „nudge“, or to take over in a manual mode.

In the sections that immediately follow, we present the options to nudge or temporarily take over from the AAPS home screen that will be serving as your **FCL cockpit:**

- Section 5.2 describes how you can use available “buttons” from your AAPS home screen, and how to complete it towards a suitable DIY FCL cockpit, for an even better FCL experience.
- Section 5.3 describes how you might be able to manage “disturbances” even better (with more convenience) with an improved FCL cockpit in the future.

5.2 Modulating aggressiveness manually, from the DIY-FCL-Cockpit*

* Like in the airplane cockpit: Cruising in full auto mode should involve having an eye on the instruments, and on potential disturbances ahead in the environment.

In section 4. we dealt with major meals. In section 5.1 we looked into fully automatable management of other situations. Life in Full Closed Loop can become extremely easy then…

However: Other **disturbances** might come up, that:

- are not noticeable in-time, or foreseeable, by the loop (*e.g. your plan to start exercise in an hour or two*), but **that influence sensitivity dramatically** and therefore require temporary non-default settings in order to remain in-range, and/or
- **require** a different “starting point” regarding iob and bg, which translates into **a different iobTH** that should **temporarily** be set much lower (*in case of exercise*) or noticeably higher (*e.g. with very fast absorbing carbs in a sweet snack “sin”*) .

In section 5.1 we looked into ways to automate also a modified loop response to *foreseeable* situations (tied to a time of day, geo-location etc), or to those *the loop could recognize* (with enough time to react).

Other „disturbances“ might come up, and you must find an easy way to

- call up a pre-programmed routine for automatic management, with adjusted aggressiveness, or:
- manually tweak a setting or two, to temporarily adjust the aggressiveness
- There may also arise a desire to just exit the FCL mode, and be your own captain for mastering a special situation.

For peace of mind, to learn, and to stay informed (especially so in your initial tuning phase, or when your glucose curve goes in unexpected ways) we also must be able to

- find the key parameters that frame and drive the recent and upcoming loop decisions.

All this is facilitated within seconds right from the AAPS home screen, serving as a **FCL cockpit** after you built a couple of DIY cockpit features via Automations (as described below and in case studies 5.2 and 6.2):

Thoughts went also into how to improve the cockpit in future releases, see section 5.3

5.2.1 Status recognition

Before considering any manual interventions into the ongoing FCL, you should be aware what the current mode of action is, and hence which button eventually to fine-tune or lever to switch, in order to adjust to the disturbance you see coming up.

See section 5.4

5,2.2 Manual interventions from the (DIY-) FCL cockpit

Trouble with all these is, not to forget to set back manually, too (=> better solutions in 5.3)

5.2.2.1 Temporary tuning of FCL aggressiveness via temp. %profile or TT settings

The set **% profile** multiplies with both, the ISF resulting from autoISF, and also with the default iobTH you have set, so both are nicely modulated in a linear way with the % temporarily chosen

Just taking profile e.g. to 110% for an afternoon might be an easy way to explore whether you might benefit from 10% more “aggressiveness” in your core settings for lunches (like bgAccel_ISF_weight). Make sure, though, that the extra 10% are not cut away by set safety limits.

A lowered (relative to profile glucose target) temporary **bg target** (**TT**) signals lowered sensitivity (more insulin need), and an elevated TT (as often used with exercise) increases sensitivity and hence works in the direction of a lowered % profile to also reduce insulin given by the loop.

Moreover, the **exercise button** (top center on your AAPS home screen) can be activated (turns yellow, then). This will **further boost** how your set TT elevates the resulting ISF, and sharply lowers iobTH, as often desired for sports. See section 6.1).

5.2.2.2 Making temporary changes in settings made in AAPS/preferences/Open APS SMB

Going into AAPS/preferences/Open APS SMB allows to:

- set milder or stronger …_ISF_weights
- set different iob_threshold_percent (or iobMAX)
- elevate or lower the SMB_delivers_ratio
- limit or expand max. allowed SMB size
- change the the even <-> odd logic for SMB on/off

Doing temporary changes in AAPS/preferences should be the exception because

- they require multiple steps, including entering a password
- you will often forget to set everything back to default a couple of hours, or minutes, later

5.2.2.3 Triggered Automations: Grey extra DIY cockpit buttons for pre-programmed “responses”

Recognizing conditions for fully automatic handling by the loop may not be not possible, or come too late for the loop to act on. Examples would be

- *exercise:* Minimum an hour before starting “the loop should know” to be able to lower iob and elevate bg by the time exercise starts.
- *snacks*: High carb snacks, sweets, consuming ice cream or having a sweet drink comes with the problem of even steeper glucose rises, but overall a lesser insulin need, compared to major meals (for which we tuned our FCL according to section 4).

This not necessarily implies that snacks need different settings than a meal. After all, autoISF was designed to act to all available data, especially to where the developing glucose curve is headed. So, depending on your effort to set parameters for a broad variety of meals (notably:

how well you avoid to invariably bounce fast against your iobTH), you might be able to accommodate low carb, snack, and major meals with *one* set of settings.

For that reason, or just for increased comfort and safety, you might want to differentiate, and make use of what follows for the *sweet snack* example.

> Note that both, FCL and HCL autoISF use all autoISF features, including ISF adaptation by bg curve behaviour. Only, in FCL no user bolus is given, and that has big consequences on how aggressively dialed in the bgAccel_ISF component is.
> In FCL autoISF, dealing with snacks (or, generally, with a very wide range of different meal sizes) is more difficult than in HCL autoISF applications, because FCL involves revving up iob supply (largely via big bgAccel_ISF-weights) often too much to be balanced by just a snack getting absorbed.

Tuning aggressiveness

Key is that a sweet snack, in absence of any pre-bolus, likely benefits from even *more aggressive initial* FCL performance than the meals in your normal spectrum of diets require.
Therefore, you could set

- a higher **temp. profile%** and/or
- a temp.elevated **bgAccel_ISF-weight** (see screenshot of my Automation).
- a **low temp. target** (76 for instance; this additionally helps maximize the first SMBs that will automatically be triggered at detection of acceleration)..

When first defining and testing this Automation, also check:

- that the safety limits as discussed in section 2 will not block the intended elevated aggressiveness
- SMBs will not get outrageously big and iobTH sometimes exceeded by too much

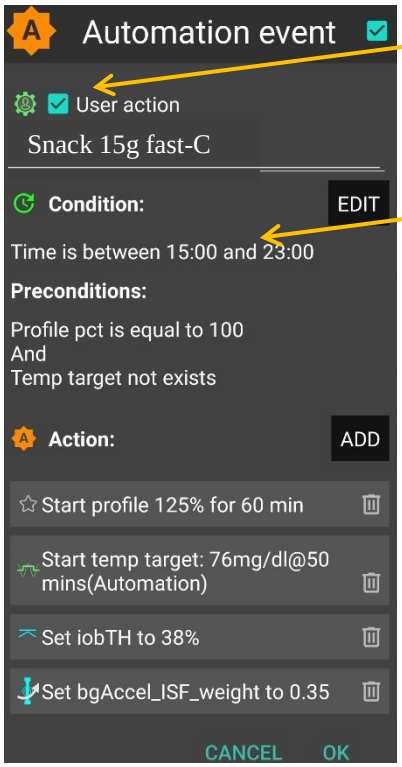
  Note that “the last SMB” is allowed to overshoot the effective iobTH by 30%

Limiting iob

For “just a snack”, total insulin need will be lower than for a meal.

If you would just have your sweet drink, and your meal-oriented FCL would “attack”, iob likely would become too high, and a glucose rollercoaster would start, with you needing to consume more =>

If you just have a snack, or drink a glass of juice, you can lower the **iobTH_percent** accordingly.



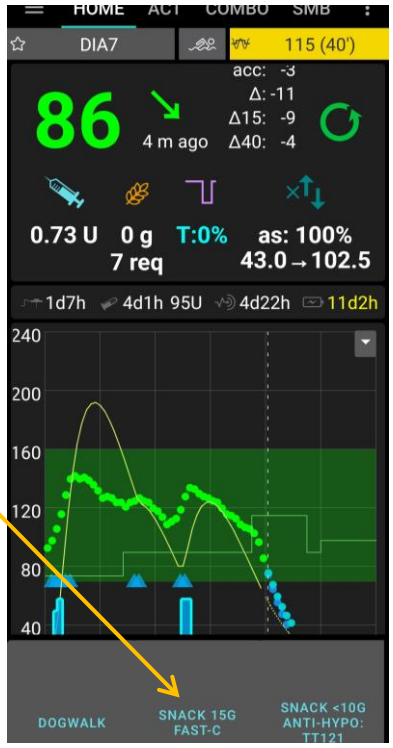
„User action“ is always ticked-on

This will, in the defined time space ..

..offer the “DIY cockpit” button..

..which I must press any time (~90…30 minutes) before my snack.

Note: Make sure that iobTH and bgAccel_ISF_weight revert to default afterwards



So, this can be a little **extra “project” when setting up your FCL**.
You need to research your snack habits (if any), and over time find out which settings in the snack-related Automations work well.

In everyday life you **then just** must **press the related button in your cockpit** (which is not time critical at all, except it should be clicked *latest* a couple of minutes after you took the drink or snack).

If you consume more, and also eat something with your sweet drink, this will more resemble a full meal… however, with unusual amounts of fast carbs.

Note: Pressing your snack button *a second time* would ***not*** help because the lowered iobTH then would not allow iob going high enough. So, if the snack keeps growing in size (not an unlikely scenario, right?), then you are better off just letting your normal FCL meal routine kick in and take over, after your snack mode expired.

Other options when snacks keep extending would require a manual modulation regarding %profile and/or bgAccel_ISF, but keeping the full default set iobTH_percent, or even elevating it (refer to section 5.2.3). If that happens often, define for yourself an extra User action Automation for a bigger snack (= another grey DIY cockpit button).

Installing the DIY cockpit button

In the related Automation, just keep the “User action” box clicked at all times, and define in the Conditions when you want to see that button available for cockpit use (see screenshot above) => you will see that button offered.

Besides snacks, also any **other recurring special situations can be addressed via a DIY cockpit button, and receive different aggressiveness up to a suitable iobTH level**.

Over time you can have a big number of User action Automations, and keep them “shelved” rather invisibly (clicked in-active, top left box) in your long list of potential Automations. Even when active, they only show in your cockpit (bottom grey field of your AAPS home screen) in the time slot you assigned as potentially relevant.

In the future you might be able to set the stage for a snack and other “disturbances” also via an extended menue below the TT button on the AAPS home screen, see section 5.3.3.1

Discussion

In case you *do have* a snack habit and

- *can not* find settings, as in section 4 defined for your meals, that *also* suit your snacks
- *can not* define an Automation as in section 5.1.4 that would pin the snack habit to a *CONDITION* (e.g. if in time window …. bg rises …)(then temp. set … e.g. as in example given above)

then you will *need* a “snack announcement”, preferably via the grey DIY button (e.g. as shown above).

5.2.4 Temporarily exiting the FCL

The “last resort” alternative always is to **temporarily** leave the FCL mode, and handle any disturbance “the traditional way” in **hybrid closed loop**.

The suggested FCL cockpit user interface with an extra version of violet loop on the AAPS home screen (section 5.3.1) would facilitate that, including automatic removal and re-appearance of the insulin button at the bottom of the APS home screen.

In case this feature is not yet available, you must:

Exit the FCL mode by going to AAPS/preferences/put in your password/OpenAPS SMB/scrolldown to autoISF settings and switch “Enable ISF adaptation..” OFF.

Unfortunately, there is no way yet for it to come automatically back on, after a selected time for instance. So do not forget to switch your autoISF fully back on, later.

As this will often be forgotten, it may be worth doing a “User action” Automation, for a “temp. FCL OFF” grey button (see section 5.2.1).

Caution though, there is very limited experience with this brand new feature

To recognize whether autoISF currently runs with ISF adaptation or not, you must consult the profile_sens -> actual_sens indicator below the Autosens%. However, this gets also modified by %profile switches or TT +/- exercise mode. So it is not as easy as it would be with the “violet loop” proposal mentioned already above.

Ultimately, you can of course study the SMB tab to find out what is going on.

Note that three things get easy confused, especially when colloquially saying “FCL is off”:

- FCL really at its core means the user does not bolus (and no carb entries). Looping in a largely hands-off way, with exceptions when unusual disturbances are encountered.
- Using autoISF means, to utilize (enable) the ISF adaptation to glucose behaviour.

  Shutting this core autoISF function temporarily off means also exiting the autoISF FCL, because to deal with meals AAPS then will require user boli.

  There are also non-core ancillary functions that come with autoISF (some of them may become integrated also in future AAPS Master versions). Please be aware that settings like SMB_delivery_ratio and also your extended SMB size limits, will apply also in your hybrid closed loop, and even if you resort temporarily to standard oref(1) SMB+UAM algorithm.

⇨ This could be a problem *in case* in your oref(1) hybrid closed loop your profile ISF was set a bit too low, and you often bounced into the 120 minute SMB size limit (…but now you must tolerate the wider limit "from autoISF" … or temp. set a lowered %profile as a parallel precaution).

- Shutting SMBs (temporarily) off is an independent measure to slow down delivery of correction insulin by the loop. Temp. shut-off of SMBs is built into the autoISF FCL for whenever iob> iobTH.
-

5.3 Modulating aggressiveness manually from the improved FCL-cockpit

autoISF 3.0 is an early dev variant of AAPS, and as user you are participating in an on-going development. Of note, autoISF 3.0 is first launched without many of the cockpit features that are presented below in this font color. (Only what is written in black is at this point of some relevance for using autoISF 3.0)

For the time being, multi-step work-arounds may become necessary

- In many cases, going into AAPS Preferences and changing settings would be needed (…plus not forgetting to change these settings back, afterwards).
- Automations allow a DIY FCL cockpit, see section 5.2 and case studies 5.2 and 6.2

This is also an open invitation for you to contact us in case you could help program a module for one of the required user interface extras.
For future integration into AAPS Master, an eye should be kept also on the question which other modes (like FCL using Automations and others mentioned in section 13.) might benefit from some of the extra features.

Keep in mind, though, that the **goal should be to interfere with the loop as little as possible**. Under the described conditions it can run **fully automatically** without any user interaction (= after the initial tuning phase, and related settings made in AAPS /preferences/SMB/autoISF. See section 4. and 5,1).

However, just like in the airplane cockpit: Cruising in full auto mode should involve having an eye on the instruments, and on potential disturbances ahead in the environment.

E.g.: storm ahead => instruct your plane to climb to another flight height.
Anology: exercise ahead => setting an exercise TT, or => pressing a button that activates a sequence of instructions (some of them probably hinging on conditions, like actual iob) how to manage through that exercise situation).

So, for the occasional „disturbance" coming up, you should find an easy way to

- call up a pre-programmed routine for automatic management, with auto-adjusted aggressiveness, or:
- tweak a setting or two, to temporily adjust the aggressiveness
- There may also arise a desire to just exit the FCL mode, and be your own captain for mastering a special situation.

All this is facilitated within seconds right from the AAPS home screen's **cockpit features** to the extent they are already incorporated, or to the extent you can build alike DIY cockpit features via Automations, as described in section 4.1.3 and case studies 5.2 and 6.2):

- The button that is integrated into the **violet FCL icon** serves as emergeny off button, to quickly stop FCL, or to at least to immediately stop any more SMBs (…just for a couple of minutes, or for the remaining meal time: pick from the options offered with just one keystroke).

  Via the violet FCL icon on your AAPS home screen, you also can access a temp. switch-off button for SMBs (see section that next follows below).

- The **three top fields** (%profile, exercise, TT) provide access to temp. tuning of core parameters, and/or to some pre-programmed routines.

Taken together with some **new indicator fields** about your loop state, and the **grey DIY cockpit buttons** this makes the AAPS home screen your **cockpit** for Full Closed Looping.

Let us look on each of these cockpit elements in some detail:

5.3.1 Violet FCL icon and underlying buttons

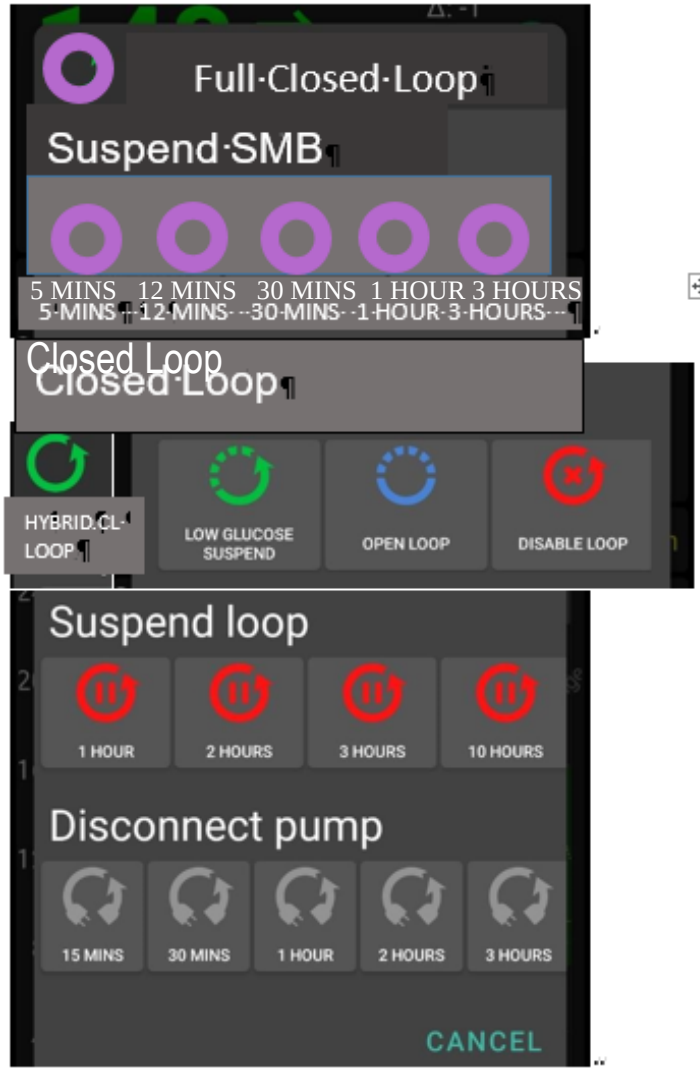
Novices to FCL, or really anyone running into a very special situation, may appreciate that the new closed loop icon on the AAPS home screen in pink (for FCL) has buttons to quickly shut off getting more SMBs (1st row), or to enter other loop modes (second row).

It functions very much as the other ones that you know from HCL already, and in fact you get offered some of the same options (for instance, to switch the (full) closed loop off for 15 minutes for going to take a shower)

Note that in FCL you leave all BG regulation, notably against meal spikes, to the loop. So, try not to disconnect in phases when your FCL must ramp up your iob.

The required insulin would still be supplied *after* you reconnect. However, without the user pre-bolussing, the delay would be more of an issue in FCL than it had been in HCL.

Just pressing on the FCL icon, a dialogue box comes up:



<-add arrow, form like like Cl.Loop

<-dotted + arrow, form like like LGS

DEV: when in Hybrid Closed Loop = top headline + green circle), there is no Suspend SMB part but it starts right with „Closed Loop". In that screen. There, the 1st element must be option to pick

pink circle, FULL Cl. LOOP

where here the green HYBRID CL. LOOP stands

For loopers who did not set up FCL, a feedback must come up ~ „FCL not installed" if they press on that button ¤

Pressing „**Suspend SMB**“provides fast and easy „emergency braking“ regarding delivery of more SMBs:
Select the one with the desired number of minutes: 5 or 12 for just blocking the potential next SMB(s), and up to 3 hours to manage the entire rest of this meal with %TBR from then on.

Whenever, and why-ever, your FCL is in „no SMBs allowed” mode (e.g. automatically after surpassing an iobTH , or triggered by a set odd TT), the FCL icon will turn into a dotted one.
Instead of remaining **duration to end time** it indicates in the middle „the condition“, „**iob**“ or „**TT**
Add an indication **if** suspend SMB comes from an Automation, e.g. add an **„ (A) „ underneath** the #minutes, iob, or TT in the middle of the dotted violet field.
So, as in other (already in HCL existing) cases, those icons show in the middle the minutes left that they will be running, or the condition which would have to go away for this temp. setting to stop.
It always auto-reverts into the FCL state and FCL icon, when time (or other condition) has elapsed.

Pressing „**HYBRID CL. LOOP**“ or other buttons from the 2nd row provides fast and easy „emergency **exit“ into other modes**.

> This enables beginners an easy „temp. escape“ into their well-known HCL (green) at any point of time. bgAccel_ISF_weight is set to zero when going FCL->HCL. HCL can run with autoISF (for instance dura_ISF) uninhibited otherwise. (check implications for HCL users of autoISF ??).

Note: These options from row 2 have no time limit. Loop will **not** by itself go back to FCL. You see the different loop icon as a reminder to manually revert, when ready.

Note (re-iterated from end of section 5.2): Three things get easy confused, especially when colloquially saying “FCL is off”:

- FCL really at its core means the user does not bolus (and no carb entries). Looping in a largely hands-off way, with exceptions when unusual disturbances are encountered.
- Using autoISF means, to utilize (enable) the ISF adaptation to glucose behaviour.

  Shutting this core autoISF function temporarily off means also exiting the autoISF FCL, because to deal with meals AAPS then will require user boli.
- Shutting SMBs (temporarily) off is an independent measure to slow down delivery of correction insulin by the loop. Temp. shut-off of SMBs is built into the autoISF FCL for whenever iob> iobTH.

5.3.2 Buttons „Insulin“, „Calculator“ etc at bottom of AAPS home screen

These buttons are **not useful any longer in FCL**, and automatically disappear whenever in FCL mode (also in Suspend SMB state), and re-appear when leaving FCL. This applies also when an Automation or technical system failure shut off FCL.

Users who, maybe in the beginning phase, feel better having those buttons, can override the removal (of the insulin button, or any other) by going into /preferences/overview/buttons and forcing them on. They only remain on until the next re-entry into FCL mode, when auto-off happens again.

The reason why we do this: It really is important to let the loop loop, and not interfere more than absolutely needed. Any bolus the user gives will sure distort the bg curve, on which autoISF, especially when aggressively tuned for FCL, builds a lot of its decisions!

5.3.3. Three top fields (%profile, exercise, TT)

Depending on the variedness of lifestyle, the desired %TIR, and the initial tuning effort put in, the user may want occasionally **to „tweek“ the aggressiveness of her/his FCL**.

The top 3 fields (grey in default mode, **yellow when temp. in mode with changed aggressiveness**) serve as quick and easy entry points to make temp. switches (as users will be used to for %profile switches, or for setting an EatingSoonTT in HCL, .. which they still can do in FCL … but more:)

Expert FCL users might need this feature rarely, but probably at least to manage activity after meals: Each require opposite aggressiveness, and the switch has to come in a certain point in time that would be difficult to capture. (More see section 6.4)

5.3.3.1 TT dialoque field ((Currently not available in the pictured form and function !)

f extended design for FCL cockpit is already launched)

The TT field (top right of AAPS home screen) is the primary daily interface, and a dialogue field opens when pressing on it

This looks complicated but only because it allows 4 different modes of use. Each user will primarily use her/his preferred one.

(1) Who is happy with the initially well tuned FCL and does not have huge variations in daily eating and moving around, will **not use** the TT **at all**. FCL is possible without an intervention via the

TT button in your cockpit. Actually 4 of 8 modes (GGG …YYY permutations, list see section 5.3.1) are not making use of TT.

(2) Super easy is also, to just input **any odd-TT** (odd-numbered temporary target) that will shut out any SMBs for the set duration. *That can be a good idea when having a snack, for instance*.

Super quick access to stop SMBs is possible also via the loop icon (section 5.2.1).

Specifically, an **EatingSoon TT** can be activated here (limited relevance see section 2.5). It is time-un-critical, can be manually set, or come up via an Automation.

The cockpit enables you to set the iobTH differently (override) for the current meal.

Alternatively, iobTH can be temporarily changed in /preferences or using an Automation.

Temp. iobTH will always revert to default when the TT expires. If another TT immediately follows, like in the example of the screen above, it will calculate, (then) show and use a new temp. iobTH.

(3) The third way is to **use the input mask** (*if already ncluded in your software version* see picture above) **to freely modulate the loop aggressiveness** for a declared number of minutes. Click the bottom big square(s): Either HYPO, or ACTIVITY, or EATING SOON, or ACTIVITY and EATING SOON (*example in the pictured screen above*). Make or override entries in the offered fields. Press OK.

(4) The fourth way is to exclusively use one of the 4+4+2 little buttons seen in the bottom part of the TT dialogue box *(if already included in your software version)*. They provide a set of settings (as will immediately show in all input fields above) that the user has set up in Preferences/SMB/autoISF/FullLoop (refer to section 6.3), and can freely label there. *For instance „hiC“ at high carb EatingSoon, „piz“ for Pizza/fatty meals, „grd“ for garden work, „mtb“ for mountain biking …*

Capturing good settings for not-everyday situations in /preferences *(if already included)* **allows calling them up within 1 second**, from your cockpit on the AAPS home screen (…and won't ruin the FCL experience at all , especially because in most cases it is not time-critical, how long before the intended exercise the buttons are pressed).

Case study 6.2 demonstrates that nearly the same performance and comfort can be reached via the **DIY FCL cockpit** with the grey extra buttons appearing at the bottom of the AAPS home screen, based on Automations with User action (see also section 4.2).

The example picture given above, and also case study 6.2, is the most complicated (but also most useful) case, **when exercise follows after a sizeable meal.** It is then that you need (a) aggressive

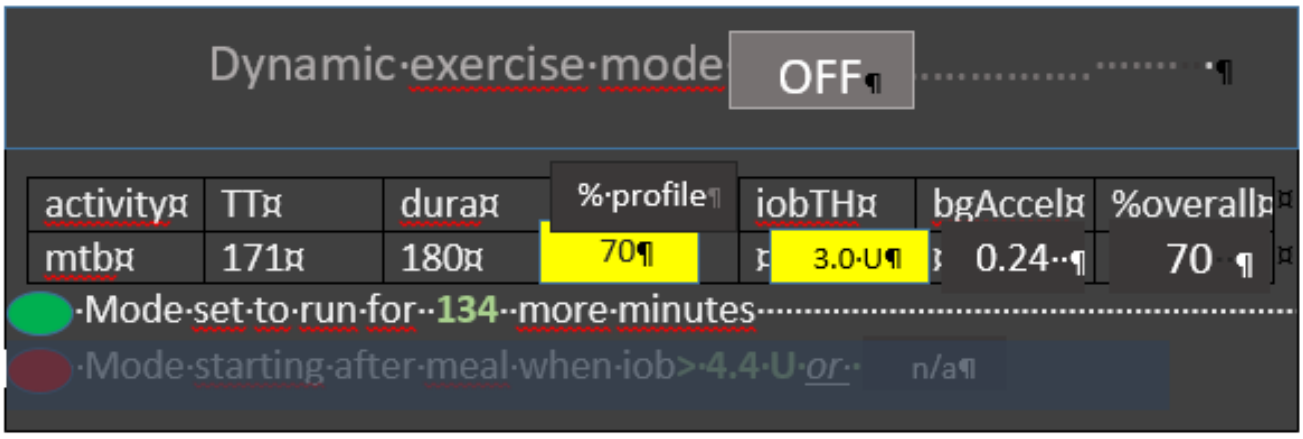
FCL initial performance at the meal, but, exactly when (!) a (for the intended sport already temp.lowered) iobTH is exceeded, you need (b) to have SMBs automatically switched off and go into the „milder“ mode, as defined for the exercise (with high instead of lowTT, that automatically significantly reduces iobTH again, and insulin sensitivity(resistance) settings too).
Pressing exercise related buttons will automatically also light the **exercise button** on the main screen yellow.

To summarize, the TT dialogue field offers easy but powerful ad-hoc modulation of loop aggressiveness for FCL (if already included).

5.3.3.2 Exercise button (see more in section 6.)

The exercise button automatically lights yellow when exercise related TTs are activated in the TT dialogue box. 4 of 8 modes are making use of the exercise button.
If pressing on the exercise button, a dialogue box appears *(if extended design for FCL cockpit is already launched)* with info on exercise setting first (and opportunity to override), plus below the activity monitor (experimental for auto-tracking of lighter movement during the day, and effects on sensitivity that may have. *See* section 4.5).

So, first the exercise settings (as set under TT) are there to read. Example :



The exercise (here mtb) is selected in the dialogue box of the neigboring TT field, and there auto-filled with settings made in the set-up and tuning stage by the user under preferences (see above,….). They are reported also under the exercise button here, and TT, duration, and % sens (which also shows active on the %profile field on the left side of the exercise button) can be temp. changed there. iobTH, bgAccel_ISF and overall resulting sensitivity ratio is given in the other fields.
The **middle field** of the table, **„% profile“** either picks up the % set under the %profile button, or an input can be made here, in the exercise button domain, which will:

- turn the neighboring %profile button on yellow and show that inputted % on it, too
- be multiplied with the result from the exercise mode settings per se, and change the % overall, accordingly.

So, if this middle field of above table (dialogue box of sports button) contains a figure other than 100, input field becomes yellow,and you are operating with a combination of traditional PLUS new exercise mode (with all three top buttons of your FCL cockpit yellow). This maximally will soften aggressiveness, for which you get an idea by the last calculated figure.

The mode is either running already (for another number of minutes, as probably also shown in the yellow TT field anyways). Or it is scheduled to run, after insulination for a started meal reaches iobTH (as in table). Or, no exercise is scheduled (both points red, no entries.

The lower part of the exercise dialogue box (not pictured above, but see in section 6.5) is dedicated to the Activity Monitor

5.3.3.3 Profile button

The profile button can still be used to set a different profile, or profile%, for instance to adjust for days with sickness (as you are used to from hybrid closed looping). 4 of 8 modes are not making use of the profile button.

Any inputs made here will be used to modify profile_ISF on which all further changes are made on (multiplied with).

The profile field remains grey if standard profile is applied.
It turns yellow, displaying a %figure relating to any altered loop overall aggressiveness:

- When no inputs (changes from 100% profile) are made here, but inputs in the TT field, e.g. for exercise, automatically lead to different insulin sensitivity ratio ~~that ratio is shown here~~
- when% is changed by input in the profile button itself, it will be multiplied with with profile_ISF and be used in place of profile_ISF *by the algorithm*.

However, for exercise (sports) you no longer must make an entry here, because reasonable %reductions should be automatically provided, driven by your set TT (and half-basal exercise target), see section 6.

5.4 Recognizing your loop state in the AAPS home screen

5.4.1 Color scheme of top cockpit buttons tells kind of closed loop that is running

3 Buttons (%profile; exercise; TT) each in 2 states (yellow Y, or grey G) makes 2 exp 3 = 8 possible combinations:

GYY = dynamic exercise mode

YGY = not-dynamic „traditional“ exercise mode (if <100%) or hypo mode (if >100%)

GYG = basic closed loop with Activity Monitor running

GGG = basic closed loop (FCL or HCL) without any altered sensitivities etc

YGG = basic closed loop but with a „long wave“ sensitivity shift (e.g. sickness)

GGY =temp. target like e.g. EatingSoonTT is set; or Hypo mode

YYG = closed loop with „long wave“ sensitivity adjustment and Activity Monitor running

YYY = dynamic exercise mode in time with additional „long-waved“ sensitivity shift

5.4.2 Information printed on the top buttons

The yellow TT field shows the currently valid TT (and further duration):

(profile) stands for the abbreviation you labeled your selected running profile

In the special case of settings for meal preceding sports, the field will look slightly differently:

…and …

… when iobTH is first time exceeded, this automatically switches to:

Likewise, if on the AAPS main screen just an **EatingSoonTT** is set (e.g.72), this is entered with the desired duration. Afterwards, it automatically reverts to profile target and the display turns grey again there with e.g. 90 on it (and no time limit).

Without sports context, the middle field remains grey.

Independently from setting a TT, the user can choose to set a **%profile in the left top field**, for an independent number of minutes, e.g. 70% in this screen example: Also, or additionally, this will influence the resulting ISF and sensitivity%

The % might change and turn yellow also in context of making TT inputs in the related dialogue box (see chapter TT dialogue field, above). Still, the % (or the length of time the profile switch shall be active) can be independently overridden in the top left field, if so desired.

If an **Automation** sets a %profile, and/or a TT *(e.g. automatic detection of meal start at condition e.g. when delta >10*) , this would automatically show in respective field(s) turning yellow and showing the temp. setting. To show the set parameter comes from an Automation, „ **(A)** „ is added in the end of button text.

Note that an Automation is usually / always (?) only permitted to temp. change default profile settings, not other pre-existing temp. settings. This is for a good reason : Why should a sometimes in the past thought-out Automation supersede your - just for the occasion specified – temp.settings that you consciously activated for the day?
Advice: Try to stay away from Automations that also aim at temp. modifying aggressiveness. For the reason just given in above note, they often will not kick in anyways. Generally, it also is no good idea to double up sub-algorithms for tweaking loop behaviours.

Try to **keep things as simple and clear as possible.**

That said, a limited number of Automations can be of help in distinct scenarios (that differ in purpose and in applicable time of day*).*

A good one could be for night time, when your odd profile TT has SMBs shut off, but your experience after pizza nights tells you that, under certain condition patterns (bg, iob), an SMB or two should be „allowed in“. Another good example, if you go usually FCL without

any use of the TT button (which you could call a meal announcement of sorts), is to define an Automation that, after detecting a meal start, automatically sets a low TT to get maximally aggressive first SMBs.

5.4.3 FCL related indicator fields in the AAPS home screen

In extra data fields of the AAPS main screen you can always see (not change) the key „aggressiveness“ parameters your loop currently operates operates with (see also home screen example below):

- how profile sensitivity (**ISF**) changes by the %profile input, by autoISF, and/or a set exerciseTT.
- next to current available iob number is an indication of your **valid iobTH** (the iob above which no more SMBs will be given)
- The AAPS home screen additionally shows, above the deltas, the current **acceleration**

  Having a look at that can be valueable. For instance, when glucose is relatively low and still falling, a positive (and getting more positive) acceleration indicates that bg will swing back up, rather than crash low. This will give info about necessary snack size, and hence help avoid both, unnecessary calories, and going on a bg roller coaster.

5.4.4 Overall home screen:

Overall home screen: