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Group Work
Planning

GW	Date	Content	Comments
01	08.05.2020	Single NMPC step in MATLAB and Simulink	
02	15.05.2020	Offset-free NMPC in Simulink and parameter tuning	Hand in your NMPC #1 for review by TAs until 20.05.2020 (23:59)
03	22.05.2020	Code optimization and advanced formulations	Hand in **two** final NMPCs until 27.05.20 (23:59). One NMPC is allowed to be non-causal
	29.05.2020	“Competition”	Controller design and performance will be presented and discussed in exercise session

- Instructions how and which files to hand in: see end of this presentation

Review GW01

Single NMPC step in MATLAB and Simulink

```
%% Definition of objective function (discrete)
% Define parameters
r       = MX.sym('r',2,1);              % Reference
du      = MX.sym('du',nInputs,1);       % Delta u
Q1      = MX.sym('Q1');                 % Weighting for p_im
Q2      = MX.sym('Q2');                 % Weighting for x_bg
R1      = MX.sym('R1');                 % Weighting for du_vtg
R2      = MX.sym('R2');                 % Weighting for du_egr
% Objective function
J       = Q1*(y(1)-r(1))^2 + Q2*(y(2)-r(2))^2 + R1*du(1)^2 + R2*du(2)^2;
% Create CasADi function
fJDisc  = Function('fJDisc',{x,du,r,[Q1;Q2;R1;R2]},{J});
```

→ Create helping variables to construct CasADi functions

Review GW01

Single NMPC step in MATLAB and Simulink

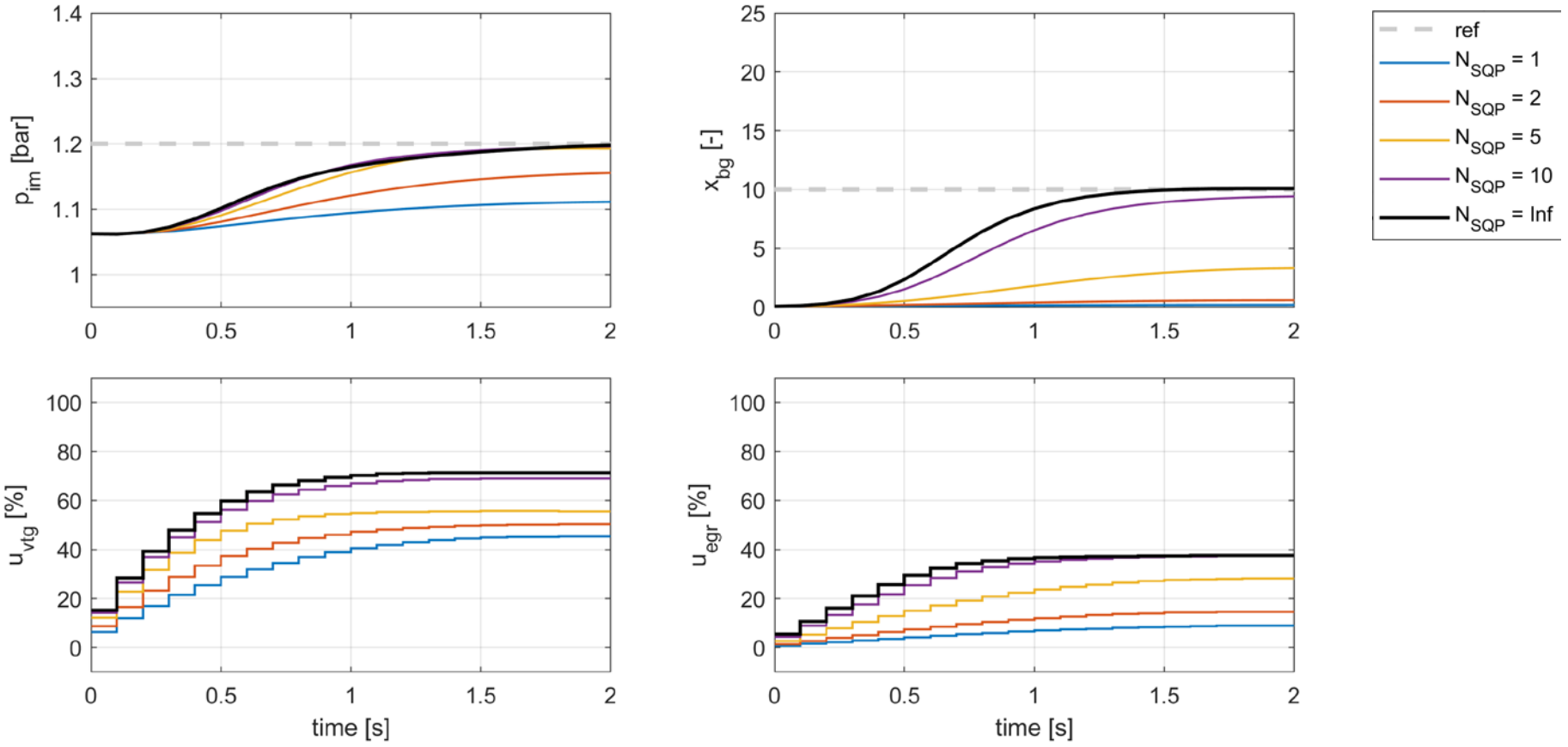
```
% Pre-define parameters
p = MX.sym('p',nStates+nInputs+nOutputs+4); % p = [x0;uprev;r;Q1;Q2;R1;R2]

% Construct NLP step-by-step
for k = 1:options.N+1
      ⋮
        % Objective function
        if k==1
            % Hardcoded initial condition uprev = p(6:7)
            Jk = fJDisc(p(1:5),U{k}-p(6:7),p(8:9),p(10:13));
        else
            Jk = Jk + fJDisc(S{k},U{k}-U{k-1},p(8:9),p(10:13));
        end % if
```

```
⋮
% Create CasADi functions
qp_W        = Function('qp_W',{optVars,[p;lambda]},{W});
qp_gradJ    = Function('qp_gradJ',{optVars,p},{gradJ});
qp_gradhT   = Function('qp_gradhT',{optVars,p},{gradhT});
qp_h        = Function('qp_h',{optVars,p},{h});
```

→ Create exogenous input p for parameters, initial conditions, etc.

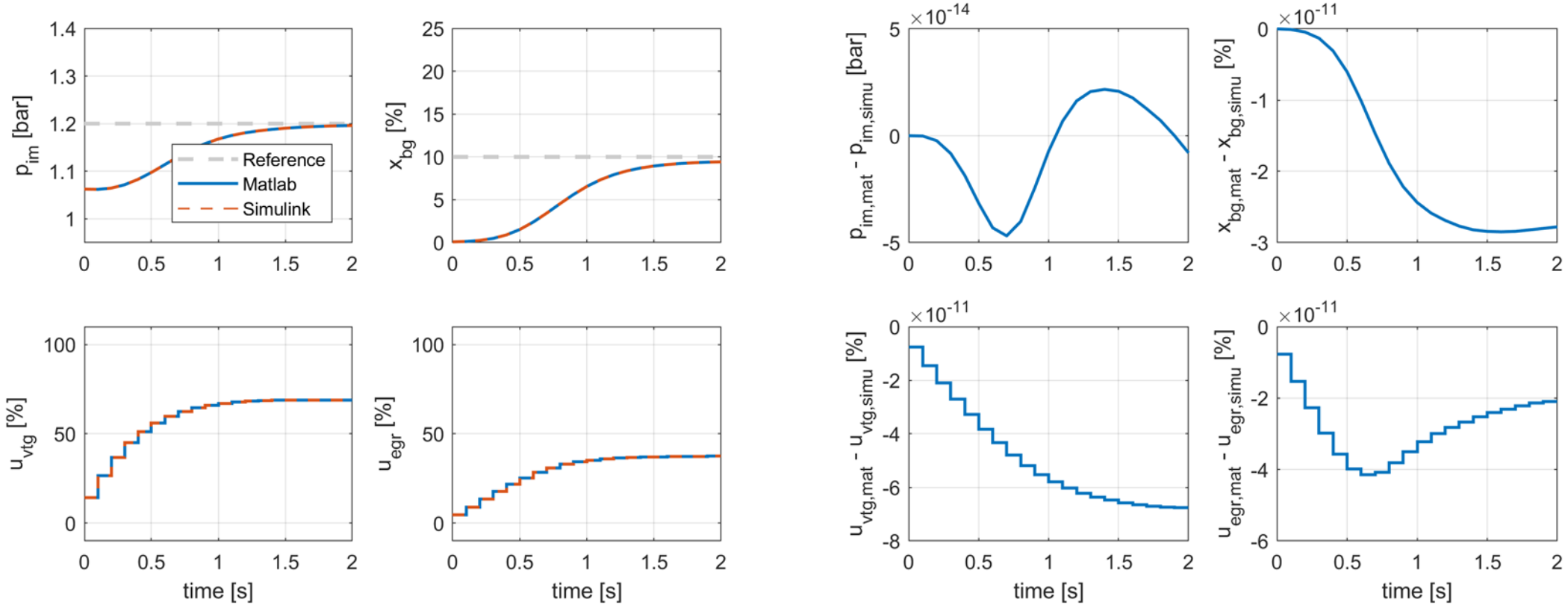
Review GW01

Single NMPC step in MATLAB



Review GW01

MATLAB vs Simulink



GW02
Steps

1. Extend single NMPC step to full NMPC implementation
   In Simulink
2. Add feedback and offset-free control
   Start with ROM and artificial offsets, then MVM (without delays)
3. Add output-delay compensation
   Test with MVM (with delays)
4. Tune your NMPC
   For good reference tracking and disturbance rejection
5. Hand in your NMPC for review by TAs

GW02
Files

Templates:

- **main_GW02.m** – Defines options and parameters (new reference trajectories), compiles C code, triggers simulations, plots results

To be handed in by e-mail, as single ZIP file, until midnight 20.05.2020:

- **cSourceFiles** folder and contents
- **sFunctions** folder and contents
- **createCasadiFunctions.m**
- **main_GW02.m**
- **NMPC.slx**