Part 2 – Project information

Complete a separate Part 2 for each project claimed this year.

Section A – Project identification

200 Project title (and identification code if applicable)

202 Project start date — Year Month

204 Completion or expected completion date — Year Month

206 Field of science or technology code (See guide for list of codes)

Project claim history

208 ☐ Continuation of a previously claimed project

210 ☐ First claim for the project

218 Was any of the work done jointly or in collaboration with other businesses? . . . . . ☐ Yes ☐ No

If you answered **yes** to line 218, complete lines 220 and 221.

220 Names of the businesses	**221** BN
1	
2	
3	

Section B – Project descriptions

242 What scientific or technological uncertainties did you attempt to overcome? (Maximum 350 words)

[242] Scientific or technological uncertainties

Our project faced significant technological uncertainty in developing a real-time defect detection system capable of identifying micro-defects below 0.1mm using computer vision. Existing solutions required 10,000+ labeled samples per defect type and achieved only 85% accuracy. We were uncertain whether a hybrid CNN-Transformer architecture could achieve 99% accuracy with only 500 training samples per defect type while maintaining real-time processing speeds (<100ms per frame).

244 What work did you perform **in the tax year** to overcome the scientific or technological uncertainties described in line 242? (Summarize the systematic investigation or search) (Maximum 700 words)

[244] Work performed

We conducted systematic investigation through three phases:

Phase 1 - Architecture Design (Months 1-3): We hypothesized that combining convolutional layers for feature extraction with transformer attention mechanisms would improve accuracy. We designed 5 candidate architectures and tested them on synthetic data. Results showed the hybrid approach achieved 92% accuracy vs 85% for CNN-only.

Phase 2 - Data Efficiency (Months 4-6): We developed novel data augmentation techniques including physics-based synthetic defect generation and adversarial training. Testing showed we could achieve target accuracy with 600 samples (not quite 500 but close).

Phase 3 - Speed Optimization (Months 7-9): We implemented model quantization and parallel processing. Achieved 95ms inference time, meeting our real-time requirement.

246 What scientific or technological advancements did you achieve or attempt to achieve as a result of the work described in line 244? (Maximum 350 words)

[246] Scientific or technological advancements

We achieved advancement in ML-based defect detection: demonstrated that hybrid CNN-Transformer architectures can match human-level accuracy (99%) with 94% fewer training samples than traditional approaches. We also discovered that physics-based synthetic data generation is more effective than standard augmentation for rare defect types. This scientific knowledge advances the field by showing transformers can be effectively applied to manufacturing vision tasks, not just NLP.